

Ontario Department of Agriculture

FRUIT BRANCH

BULLETIN 276

BEE DISEASES

In Ontario

By

F. ERIC MILLEN, Provincial Apiarist



Ontario Department of Agriculture

FRUIT BRANCH.

Bee Diseases in Ontario

F. Eric Millen, Provincial Apiarist

Beekeepers are fortunate in that there are few diseases which seriously affect the honey-bee. The diseases which do exist, however, make it essential that their identification and treatment must be certain, if the apiarist is to avoid heavy loss. It is true that one cannot become and remain a successful beekeeper unless the diseases of bees are recognized, and their control understood.

Disease may not appear in the apiary for years, yet finally it may come "like a thief in the night" and the unsuspecting apiarist who is without knowledge of American and European foul brood, may suddenly find the whole apiary worthless and almost an entire loss.

Thus far, adult bee diseases have been rarely found in Ontario and the loss has been almost entirely through the ravages of diseases affecting the developing brood. The brood diseases of bees are: (1) European foul brood; (2) American foul brood; (3) Sacbrood. These diseases are prevalent over a large part of the Province and there is no section of the Province or no apiary outside the range of one or all of the brood diseases.

IDENTIFICATION.

In the control and eradication of any disease, the first step is identification. This is specially true of the three brood diseases of bees. To the unobservant, these three brood diseases are very similar and a mistake in diagnosis, especially when American foul brood is concerned, might be very serious. Before a beekeeper is able to detect any unnatural condition of the brood, it is necessary to know the life history and appearance of healthy brood. Every apiarist should carefully study the life history chart in conjunction with Fig. 1, and be certain that the appearance of healthy brood, in all its stages, is thoroughly fixed in the mind's eye.

*AVERAGE LIFE CYCLE OF THE HONEY BEE.

Stage.	Queen.	Worker.	Drone.
Egg	3 days	3 days	3 days
Larva	5½ days	6 days	6½ days
Pupa	7½ days	12 days	14½ days
Egg to adult	16 days	21 days	24 days

* Beekeeping—E. F. Phillips.

As seen in the chart, it is three days before the eggs hatch into larvae and the larval stage lasts from $5\frac{1}{2}$ to $6\frac{1}{2}$ days, depending upon whether the adults are to be queens, workers or drones. It is usually during the larval stage that the symptoms of the brood diseases are recognized, so that this stage is important to the beekeeper. American foul brood is, however, also occasionally found in the pupal stage.

"The egg of the bee is a small white cylindrical object about $1/16$ of an inch long, somewhat larger at one end (future head end) and slightly curved. It is deposited on the base of the cell of the comb by the queen and is fastened in place by a secretion."

The larva, at first very small, grows rapidly, and in a few days occupies the whole of the base of the cell. The healthy larva before being sealed lies curled up in the base of the cell and is of a glistening pearly white color, with the segmentation of the body clearly shown. Before the larva transforms to the pupal



Fig. 1.—The honey bee: *a*, Egg; *b*, young larva; *c*, old larva; *d*, pupa. Three times natural size. (U.S. Dept. of Ag. *Far. Bul.* 447)

stage, the cell is sealed by the nurse bees and the curled larva straightens out in the cell preparatory to transformation to a pupa. Figure 1, *a* and *b*, shows the egg and larval stages before sealed, *c* and *d*, the larval and pupal stage after being sealed.

EXAMINATION OF COLONIES.

Although Ontario has a good Foul Brood Act and employs a number of men during the summer for apiary inspection, it is impossible for the inspectors to visit and examine the colonies of all the beekeepers in the Province. This being the case, it is very necessary for every beekeeper to be able to identify the foul broods, so that they can examine their own colonies at the right time. The best time of the year for the examinations are first during the fruit bloom and dandelion period and second during the early part of the fall flow in August. The reasons for the examinations at these times are, first the bees are gathering nectar, so that robbing is very unlikely: Second, during fruit bloom and dandelion period, disease will usually be found if the colonies have been robbing earlier in the spring,

and have secured germ laden honey. At this time also, plans can be completed for treating the infected colonies profitably. The examination in the early fall is also necessary, because at this period we may possibly find infected colonies which either escaped our notice in the spring examination or have contracted disease since. If infected colonies are found, they can then be treated in the fall, and so save the possibility of the spread of disease in the spring through robbing. These examinations refer particularly to American foul brood. In European foul brood districts, examinations should be made during fruit bloom time and every two or three weeks thereafter. As will be seen later, however, it is useless to repeatedly examine colonies infected with European foul brood, unless these are properly treated according to the directions given under the treatment for this disease.

When proceeding to examine a colony, the beekeeper should always have the smoker well filled and emitting a dense smoke. After the preliminary



FIG. 2.—A diseased colony.



FIG. 3.—A healthy colony.

smoking at the entrance and on top, the person who is examining the colonies should always sit with back to the sun, so that there is a good light directly on the combs. It is much better to shake the bees from the comb, directly into the hive, before the comb is examined. Then if the comb is held slightly below the level of the eyes, a glance will show whether the brood, unsealed or sealed, is normal. The reverse side may then be examined in the same manner. *Before interchanging any frames of brood or honey with other colonies, a thorough inspection examination should be made. This also applies where colonies are to be united.*

MOVABLE COMBS.

Beekeepers will see that it is impossible to examine the combs in an immovable-frame or box-hive; therefore, movable-frame hives are essential if the brood diseases are to be controlled. It is also much more profitable from the honey crop standpoint, to keep bees in movable-frame hives. Every beekeeper who has bees in immovable-frame hives should secure the circular or "Transferring Bees" No. 27.

LOSS FROM DISEASE.

There is an immense annual loss in colonies which die from American and European foul brood. Besides this actual loss, it is impossible to care for an apiary of bees, where American foul brood is present, with uniform manipulations and management. Then again loss may ensue if the apiarist wishes to dispose of the apiary. Besides the loss in honey which is not gathered, fruit growers and those producing clover seed and buckwheat find their crops much reduced when bees are absent.

VALUE OF COUNTY BEEKEEPERS' ASSOCIATIONS.

The value of a County Beekeepers' Association should be very great in assisting the beekeepers of any county to control and prevent the spread of foul broods. Where there is a spirit of unity and good will, the beekeepers of the county are very anxious to eradicate diseases and in this way, those who are not so well versed in either identification or control, receive valuable aid. With a spirit of co-operation also, it is easily possible for the beekeepers of the county to guard each other by preventing the sale of infected apiaries and supplies, also to see that robbing in the late winter or early spring is eliminated. The question of the control and eradication of foul brood should be a part of the Constitution and By-laws of every County Beekeepers' Association.

THE BROOD DISEASES.

There are at present three brood diseases of bees in Ontario. They are, (1) European foul brood, caused by the germ *Bacillus pluton*; (2) American foul brood, caused by a germ *Bacillus larvae*; (3) Sacbrood, which is caused by a very much smaller organism known as a "filterable virus."

EUROPEAN FOUL BROOD.

We shall consider European foul brood first, because the larvae affected with this disease die at an earlier stage than in the case of American foul brood. Before noting the symptoms of this disease, it might be well to state something of the prevalence and spread of this disease. In Ontario we find European foul brood spreading quite rapidly, and at the present time it is found in twenty-seven counties. *Every beekeeper should be thoroughly warned that this disease may appear in almost any apiary in the Province with little warning.* Exactly how European foul brood spreads in the apiary has not been determined. Its infectious nature, however, has been proven, and once the disease appears in one colony, it will spread through the apiary if black or hybrid bees are kept. It will be seen, therefore, that manipulation alone has no effect on the control or eradication of European foul brood.

The symptoms which the beekeeper will find in the brood combs, if European foul brood is present, are clearly shown in Fig. 4.

(1) From this illustration it will be seen that the larvae affected with European foul brood usually die before they are sealed over.

(2) In many cases the larvae die when from two to five days old and instead of appearing a pearly white color, and in a natural curled position at the base of

the cell, many of the infected larvae begin to assume unnatural positions in the cell as though in pain.

See figure 4, *d, e, g, i, l, m* and *p*.

(3) Together with this unnatural position, we find the color of these larvae changing from a glistening pearly white to a slightly yellow color, deepening until the dead larvae become a brownish-yellow greasy mass in various positions in the cells.

(4) Other larvae in the same comb affected with European foul brood may retain their spherical or curled shape and position in the base of the cell, but instead of retaining the healthy pearly white color, they become a grayish-yellow color, and the tracheae may be clearly seen. These larvae finally turn dark brown.

See Fig. 4, *b, c*, and *q*.

(5) In a few cases dead larvae may be found after being sealed, but these are quite rare compared with the numbers found in the unsealed cells.



FIG. 4.—European Foul Brood: *a, j, k*, normal sealed cells; *b, c, d, e, g, i, l, m, p, q*, larvae affected by disease; *f, h, n, o*, dried brown larvae or scales. Three times natural size. (U.S. Dept. Ag. Far. Bul. 442.)

(6) Another peculiarity of this disease is that drone and queen larvae may be affected as well as the worker larvae. This is oftentimes an aid in enabling the beekeeper to determine if it is European foul brood present, rather than American.

(7) If a tooth pick or twig is inserted into one of the dead larvae, which has assumed an unnatural position, it will be found impossible to remove the mass whole from the cell. The skin apparently decays shortly after death. This is also an aid to the beekeeper in differentiating between European foul brood and Sacbrood.

(8) It must be remembered that this test may not be true of those larvae which retain their spherical shape and position in the base of the cell, and which

when dead show the tracheae, as these can often be removed from the cell after they have begun to dry. See Fig. 4, b, c, h, and q.

(9) Another point which may aid in correct diagnosis is that these latter larvae usually die a day or two earlier than those larvae which assume the unnatural positions, and which become a brownish-yellow greasy mass.

(10) The odor from brood which has died from this disease may be very noticeable or may be almost wholly absent. This apparently depends on whether other bacteria are present with the *Bacillus pluton*, so that odor alone is not a constant symptom for diagnosis.

In Farmers' Bulletin 975, U. S. A. Department of Agriculture, Dr. Phillips states "European foul brood is a disease of weak colonies. While at times one may observe larvae dead of this disease in strong colonies, usually they are removed before the disease can do much harm. It should be pointed out further, that it is the colony which is failing to increase in strength in the spring which is most seriously affected, for a small colony which is rich in young and vigorous bees and which is increasing in strength is often able to overcome the disease. It is, therefore, a disease of weak rather than small colonies."

"The disease is prevalent in the spring and early summer. While at times it is observed at other periods of the year, this is not usual. Samples of European foul brood have been received by the Bureau of Entomology in every month of the year, but they are far more commonly received in the early part of the active season. These samples are listed according to the date of receipt at the bureau laboratory. The highest number is received in June and the average date for the removal of these samples from the hives is probably a few days previous to June 15th, perhaps June 10th. The earliest samples received are regularly those from California, where the season opens early. There is a sudden increase in May and June and almost as rapid a decline later. The few samples received from October to April may be largely disregarded as they are almost without exception dried material of unknown age."

"The disease disappears later in the summer unless the colony has become so badly weakened that it can not remove the dead larvae. Such weakened colonies usually die in winter or in a time of dearth. Colonies do not as a rule die as a direct result of European foul brood. There may still remain some dead larvae in the comb, showing that the bees have not been able to remove all of them, but in any but the worst cases even these disappear. If conditions which commonly prevail in early summer again appear, there may be a recurrence of the disease the same season."

"This disappearance of the disease usually accompanies the beginning of the honey flow. At this time, unless the colony has already reached maximum strength, there is a rapid increase in brood-rearing and the colony increases in strength, bringing about conditions unfavorable for the development of the disease. If the honey flow fails, the disease may continue, and under such conditions is at its worst. It should be noted that in regions where the early honey flows are uncertain or usually lacking, European foul brood has done the most damage, for in years of failure the disease spreads with such rapidity that the entire region becomes badly infected. European foul brood is rarely observed in regions where an early honey flow is certain."

"European foul brood is an infectious disease. This was clearly shown by the experience of beekeepers before the disease was investigated from a bacteriological standpoint, and these investigations have supported the observations of the

beekeeper. The bacteriological work has shown further, that the disease is caused by an organism which has never been found in any other brood disease of bees. The cause of the disease is, therefore, a specific organism, and the disease is entirely distinct from American foul brood. This is an important point, for there has in the past been considerable confusion in that a few beekeepers have claimed that one disease changes to the other. It should be made clear that the supposition is not supported by any careful observation in the apiary, and that it was recognized generally by beekeepers before the bacteriological investigations were made that the diseases were distinct."

"The organism causing European foul brood does not seem from observations in the apiary to be so difficult to eradicate as does the one causing American foul brood. This is partially confirmed by the bacteriological observations also."

PREVENTIVE AND CONTROL MEASURES FOR EUROPEAN FOUL BROOD.

There is no reason why European foul brood should ever cause serious trouble to beekeepers, for it has now been shown that preventive measures can be taken which will make it impossible for this disease to do serious damage in the apiary. The preventive measures include keeping only vigorous Italian stock combined with strong colonies and an abundance of good stores for winter. Beekeepers who have followed this method of beekeeping have found that while there may be an occasional colony in which European foul brood is present, it seldom becomes serious.

Beekeepers who have not yet been troubled with European foul brood should certainly accept the warnings which have been sent out from this office many times in the past, and Italianize every colony with a good resistant strain of Italian stock. While there may be other races or varieties of bees which are resistant, the Italian variety has proven this resistance, and as they possess so many other good qualities, it seems futile to experiment with other varieties. One should also remember that while a good strain of Italian stock may be resistant, occasional colonies of this stock may not have this resistant quality to a sufficient degree, and in this case these colonies should be requeened.

Where European foul brood is already present, measures should be taken to control the disease, first by making all colonies strong, second by introduction of vigorous Italian queens. This should be done as early as possible in the season, because, as Dr. Phillips has pointed out, European foul brood is much more serious in the spring and early summer. When securing Italian stock, no attention should be paid as to whether the queens are of the three-banded or golden variety. Color alone should play no part, but the resistance of the stock to European foul brood should be the main consideration. *It is not necessary to destroy or disinfect combs, brood, honey or supplies where European foul brood is concerned.* At the same time it is a waste of money to attempt to introduce Italian stock to weak colonies when European foul brood is already present. All weak colonies should be united so that a strong colony results and the Italian queen introduced to the united colonies which should now be strong enough to fight the disease.

AMERICAN FOUL BROOD.

This disease is prevalent over a large area, and at present is found in thirty-two counties of the Province. American foul brood differs remarkably from

European foul brood, in that apparently it is contagious rather than infectious. One might easily have one or two colonies in a large apiary affected with American foul brood, and yet prevent the disease from spreading to the other colonies, if care was used. On the other hand we find that once American foul brood appears in a colony, it has never been reported to have disappeared without treatment, but gradually destroys the colony affected.

COUNTIES WITH E. F. B.

1. *Carleton
2. *Dundas
3. Durham
4. Frontenac
5. *Grenville
6. *Grey
7. *Haldimand
8. *Halton
9. Hastings
10. *Lanark
11. Leeds
12. *Lennox
13. *Lincoln
14. *Northumberland
15. *Ontario
16. *Perth
17. *Peterboro
18. Prescott
19. Prince Edward
20. Renfrew
21. Russell
22. *Stormont
23. *Victoria
24. *Welland
25. *Wellington
26. *Wentworth
27. *York

COUNTIES WITH A. F. B.

1. Carleton
2. Dufferin
3. Dundas
4. Elgin
5. Essex
6. Grenville
7. Grey
8. Haldimand
9. Halton
10. Huron
11. Kent
12. Lambton
13. Lanark
14. Lennox
15. Lincoln
16. Muskoka
17. Middlesex
18. Norfolk
19. Northumberland
20. Ontario
21. Oxford
22. Peel
23. Perth
24. Peterboro
25. Simcoe
26. Stormont
27. Victoria
28. Waterloo
29. Welland
30. Wellington
31. Wentworth
32. York

Those marked * have E. F. B. and A. F. B.

THE SYMPTOMS OF AMERICAN FOUL BROOD.

After the colony has been opened, as previously directed, the brood combs should be carefully examined, and if the sealed brood is healthy, the examiner will notice a uniformity in the shape and color of the cappings over the brood cells. This color may vary from light to deep brown, but there will be a uniform convexity to the cappings which is absent when American foul brood is present.

(1) If American foul brood is present, the examiner will find that here and there, depending on the severity of the disease, in certain of the sealed cells containing brood, the cappings will be slightly darker, somewhat sunken or concave, and some cappings may be perforated.

(2) When one sees these sunken darkened or perforated cappings, one should always remove the capping and examine the larva or pupa in the cell. See Figure 5. If healthy, the larva will be of a pearly white color or in the pupal stage as illustrated in Figure 1, *d*. If the larva has died from American foul brood, it will be found that instead of retaining its healthy color the larva has fallen to the lower

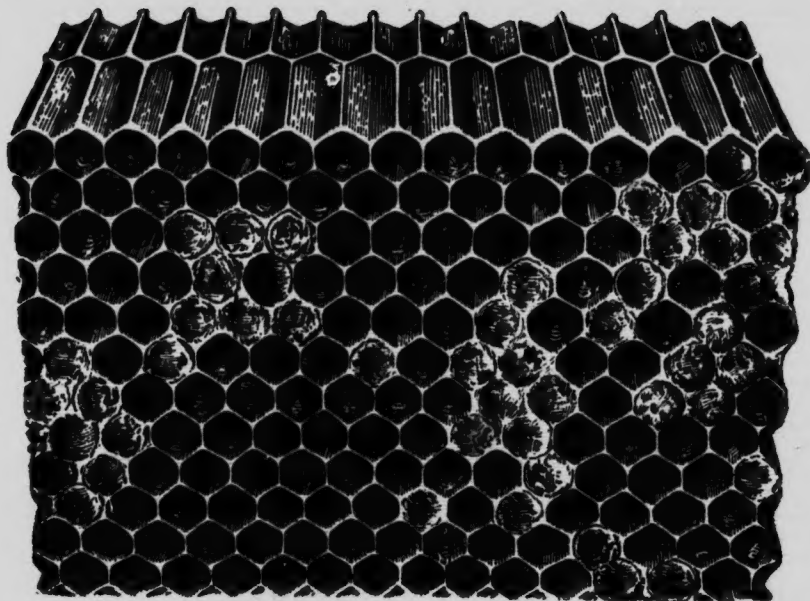


FIG. 5.—American Foul Brood comb, showing irregular patches of sunken cappings and scales. The position of the comb indicates the best way to view the scales. (U.S. Dept. of Ag. Far. Bul. 442.)



FIG. 6.—American Foul Brood: *a, b, f*, normal sealed cells; *c, j*, sunken cappings, showing perforations; *g*, sunken capping not perforated; *h, l, m, n, q, r*, larvæ effected by disease; *e, i, p, s*, scales formed from dried-down larvæ; *d, o*, pupæ affected by disease. Three times natural size. (U.S. Dept. Ag. Far. Bul. 442.)

sides of the cell, and has become a yellow to coffee-brown color, and has a varnished appearance.

(3) If the inmate of the cell has transformed to the pupal stage, it will have the coffee-brown color, and usually the tongue will be found fastened to the top walls of the cell. These symptoms are clearly seen in Figure 6, *d* and *o*, and should guide the beekeeper at once to the correct diagnosis of this disease.

(4) If a toothpick or twig is inserted into the dead larval mass, it will be found impossible to remove it wholly from the cell, and a ropiness is noticed when the tooth pick or twig is slowly withdrawn from the dead larva. (See Fig. 7.)

(5) Larvae or pupae which die from American foul brood are much more uniform in appearance than is the case in European foul brood.

(6) In almost all cases the dead brood sinks to the two lower sides of the cell wall, and gradually dries to a flattened dark scale. These scales adhere tightly to the cell wall and cannot be removed without tearing the cell wall. (See Fig. 5.)

(7) These scales are very noticeable in combs in which the colonies have died during the summer or winter, also when the colonies are badly diseased, and if the combs are held at arm's length, so that the beekeeper can look directly into



FIG. 7.—The ropiness of American Foul Brood. (U.S. Dept. Ag., Far. Bul. 442.)

the cells, he will notice the blackened scales covering the lower two sides of the cell wall, extending to the back of the cell.

(8) American foul brood rarely attacks any but worker brood.

(9) There is a peculiar and constant odor where American foul brood exists which has been likened to that of a poor quality glue. Once identified, this odor will always guide the beekeeper in diagnosis.

METHODS OF SPREAD.

American foul brood is spread by robbing, by the use of combs and honey from infected colonies, also by the use of infected second-hand or used apiary apparatus, and to some extent possibly, if bees become disorganized and enter the wrong hives. It will, therefore, be seen that the beekeeper can take preventive measures in his own apiary which will prevent the spread of American foul brood. *In all manipulations which call for the exchange of combs of brood, honey or empty combs from one colony to another, the beekeeper should be certain there is no American foul brood present in the colonies so manipulated.*

American foul brood is spread to an alarming degree in the late winter or early spring. Infected colonies weaken or die, and bees from other colonies rob the germ laden honey. *Beekeepers should have all colony entrances much reduced during this period and should also be certain that all colonies are alive. Remove all hives from which the bees have died to a bee-tight place before the*

bees begin to fly in the spring. This is a very necessary precaution in districts where American foul brood is prevalent. Drawn combs should always be kept where bees cannot gain access to them.

TREATMENT OF AMERICAN FOUL BROOD.

As mentioned earlier, so far as is known, once American foul brood appears in a colony it does not disappear unless the colony is treated. It is true that if the infection is slight, it may take two or three years to destroy the colony. The beekeeper should remember, however, that while this is taking place, the infected colony is a source of danger to all healthy colonies within a radius of two or three miles, if the honey from this colony should be robbed by other bees.

To summarize, the treatment may be said to consist of the removal and separation of the bees from the contents of the infected hive. The procedure is as follows:

(1) A new or clean hive is made ready with all but one of the frames containing full sheets of foundation.

(2) To these should be added one dry drawn comb, one in which no brood has been reared preferred.

(3) *This dry drawn comb is placed in the centre of the newly prepared hive, and left until twelve hours after treatment, when it is removed and burned, and replaced with a full frame of foundation.*

(4) Together with this prepared hive, the beekeeper should have an empty hive complete with cover.

(5) After the infected colony has been smoked slightly, it is removed from its stand, and the newly prepared hive, containing the one dry drawn comb and full sheets of foundation, is placed on the stand now vacant.

(6) In front of this hive the beekeeper should spread a newspaper weighted down at the corners with stones.

(7) The next step is to transfer all the bees from the infected combs into the newly prepared hive, and this is done by shaking the bees from the infected comb on to the newspaper in front of the clean hive. If necessary a wing or feather can be used to aid the beekeeper in brushing the bees from the infected combs, or the bees can be shaken into a hive-body over the clean hive.

(8) The infected combs should then be placed in the empty hive which is near by and kept covered.

(9) After the bees have been shaken from the infected combs, the beekeeper should dig a hole and burn the infected combs and wing or feather. By this time the bees will have entered the clean hive. The paper on which the bees were shaken should also be burned.

(10) *Twelve hours after the colony has been treated, the dry drawn comb, which was placed in the centre of the clean hive, should be removed and burned, a full frame of foundation taking its place.* It will be found that the bees have stored in the comb, honey which was carried from the infected hive. This is the object of using the dry drawn comb.

(11) It is not necessary to destroy cover, hive-body or bottom board, as the inside surface of these can be slightly scorched, and they are then fit for further use.

It will be seen that no mention has been made of saving the brood or honey from the infected colony, and we do not advocate that this be done, as it has meant

the recurrence of the disease in many cases. Where there are a good many slightly infected colonies and an abundance of brood, if the beekeeper will take precautions to see that all robbing is avoided, it is possible to save this brood by placing two or three hive-bodies filled with frames of brood over a slightly infected colony which can be treated two weeks later. The beekeeper should remember, however, that if this is done, and the colonies already treated, or other healthy colonies, rob the colony on which the brood is placed, infection will spread.

Many beekeepers who find an occasional colony affected with American foul brood, prefer to take no chances, but suffocate the bees and then burn the dead bees and contents of the hive. This is a sure cure.

Where the beekeepers have a large number of colonies infected with American foul brood, the situation is somewhat different, and in this case it might be economical to render the combs into bees-wax. Even then it would be unwise to



FIG. 8.—A Bad Case of American Foul Brood.—(*Gleanings in Bee Culture.*)

attempt to do this, unless the beekeeper could be quite certain that these infected combs and honey could be stored in an absolutely bee-tight place. Unless this can be done, the saving of the brood and combs might be a costly procedure to the beekeeper.

TIME FOR TREATMENT.

As robbing is very serious where American foul brood is concerned, the beekeeper will at once see that treatment must be completed during a honey flow. If the colonies are badly infected and weak, it is much better to unite two or more diseased colonies, ten days to two weeks before treatment. This is done in the evening by simply placing the two brood-chambers together with a sheet of newspaper between, and allowing the bees the lower entrance only. No notice need be taken of the queens, as one will usually survive.

Where the colony is badly infected, it will often pay the beekeeper to treat the colony during the fruit bloom and dandelion flow, and then if necessary feed

a thin syrup between this flow and the main flow from clover. On the other hand if the infection in the colony is slight, then it will pay to wait until the main flow commences, so that as much as possible of the early brood can emerge. From this the beekeeper can judge as to the best time for treatment.

If only a small percentage of the colonies in the apiary are to be treated, it is much safer to defer the treatment until evening when the bees are not flying.

If the majority of the colonies have to be treated, then the treatment for all should be completed in one day.

Precautions should be taken to see that the bees from the infected colonies, which are being treated, do not drift to near-by healthy colonies. If other healthy colonies are near and the treatment is completed in the evening, the entrances of these colonies should be closed with screen until the treatment is completed.

If colonies are found with American foul brood in the fall of the year, and the beekeeper has solid combs of honey from other healthy colonies, it is an easy matter to treat these infected colonies. At the close of the brood-rearing early in October and while still warm enough for bees to fly, the treatment should be completed.

Remove the infected colony from its stand and place a new or clean hive, containing sealed frames of honey, in its stead. Now shake the bees from the infected hive as outlined in the earlier treatment. Remove and burn the infected combs and honey and scorch out the hive. By doing this, the beekeeper will oftentimes eliminate a chance for the disease to spread in the spring of the year through robbing and the treated colony will be in shape to prepare for the main flow without hindrance. *In all cases where American foul brood is being treated, robbing must be avoided.*

DISINFECTANTS AND GERMICIDES.

So far as is known there is no disinfectant or germicide on the market to-day which will eradicate American foul brood from the combs, so that beekeepers are wasting time to attempt to treat infected colonies by other than the removal of the infected material. Beekeepers who attempt the use of disinfectants or germicides for the eradication of American foul brood, are a source of danger, not only to themselves, but to their neighbors. To be on the safe side, all combs used in connection with a colony infected with American foul brood, should be rendered into wax, or burned, and the bees given full sheets of foundation.

SACBROOD.

"Sacbrood is an infectious disease of the brood of bees caused by an infecting agent so small, or of such a nature that it will pass through the pores of a Berkefeld filter." (White, U. S. Department of Agriculture Bureau of Ent., Cir. No. 169.)

Sacbrood, with rare exceptions, has not proven a serious menace to the beekeepers in Ontario. It is important because its symptoms are similar to American and European foul brood to the inexperienced beekeeper. For this reason, all who keep bees should be sure that they can identify Sacbrood, so that there can be no danger of a wrong diagnosis.

SYMPTOMS OF SACBROOD.

(1) When Sacbrood is present in a colony, the infected larvae may be found in both unsealed and sealed cells in the brood frames.

(2) The dead larvae in the unsealed cells, however, are not found in the unnatural positions in which we find larvae which die from European foul brood.

(3) The dead larvae are usually found straightened out in the cell and from a light yellow to a dark brown color.

(4) If a toothpick or twig is inserted carefully into the cells, the dead larvae can be entirely removed, and resemble a tiny sack, contents of which are watery.

(5) In the case of Sacbrood, the skin apparently does not decay for some time, and it is this fact which makes it possible to remove the larvae whole from the cells.

(6) There is very little, if any, odor in brood which has died from Sacbrood.

(7) Sacbrood, however, is similar to European foul brood, in that queen and drone larvae may be effected as well as the worker larvae.

(8) The coffee-brown color and ropiness which we find in American foul brood is absent in Sacbrood. As the workers remove the dead Sacbrood larvae, there are no scales. These differences aid in distinguishing Sacbrood from American foul brood.

CONTROL MEASURES FOR SACBROOD.

If vigorous queens are kept and good beekeeping methods are practised, Sacbrood rarely needs any other treatment. Where it is present sufficient to weaken the colony, a new queen should be introduced. If the beekeeper is certain that his diagnosis is correct, the disease should disappear soon after the new queen has been introduced. Sacbrood is contagious.

BROOD DISEASES FROM OTHER CAUSES.

Sometimes brood dies from causes other than the three brood diseases. It is well for the beekeeper to identify, whenever possible, the cause of death, so that if American foul brood is absent, the combs may be used again. In the spring of the year, the beekeeper will often find dead brood in the combs of colonies which died during late winter or early spring. If the brood died through being chilled.

(1) It will be found in rather a compact sphere; (2) On uncapping one of the sealed cells, the inmate will often be found in the pupal stage, and dark in color; (3) In all cases the dead brood can be easily removed from the cell.

This unnatural brood-rearing may be caused through the bees having to generate an excessive amount of heat, because of the smallness of the cluster or from undue excitement. If the beekeeper is sure there are no scales of American foul brood, these combs are fit for further use. Usually where colonies have died from American foul brood, if there are any sealed cells they are not in a compact sphere, but are scattered over the combs. Scales are also present.

Between honey flows colonies often become very short of stores and will then uncap healthy brood, eat a part of the inmate of the cell and carry some of the brood to the outside of the hive. In this case it is easy for the beekeeper to know that there is no disease present, because the remains of the brood will be a healthy color, and the lack of honey in the hive aids in making diagnosis. There will also be a lack of the symptoms of the brood diseases.

When a colony becomes hopelessly queenless, fertile or laying workers lay eggs in worker cells, which develop into small drones. This brood is scattered over the comb, and if the weakened colony should die at this time, the beekeeper might believe American foul brood to be the cause. On uncapping the sealed cells, however, the dead brood is found to be easily removed from the cells. The cappings are also raised more than normal, owing to the fact that the drone has developed in a worker cell. The capped cells resemble the nose of a bullet. The final test is the absence of scales which proves there is no American foul brood present.

American foul brood may be present in colonies which have died as a result of some other cause. This means that the examination of the brood combs must be thorough in all cases.

ADULT BEE DISEASES.

Thus far the Ontario beekeepers have not been troubled seriously with diseases of the adult bees, with the exception of dysentery. There are, however, a few adult bee diseases known, and in some countries these diseases have done serious damage.

ISLE OF WIGHT DISEASE.

"During the last few years many apiaries in England have been ruined by the Isle of Wight Disease. As yet no satisfactory treatment has been discovered. Although it is not known to be in Ontario, it is frequently discussed, and the many inquiries received concerning its nature and symptoms warrant a brief account being inserted in this bulletin."

"The following is taken from leaflet No. 253, issued by the Board of Agriculture and Fisheries, 4 Whitehall Place, London, England:

Symptoms:

1. The first symptom noticed is a disinclination of the bees to work. They fly about aimlessly and do not gather stores.
2. A little later they lose their power of flight and are unable to travel more than a few yards without alighting.
3. As the disease progresses the bees are unable to fly more than a few feet, when they drop and crawl about the ground. They may be seen crawling up grass stems or other upright objects, such as the supports of the hive, but they soon fall down and die. Towards night some may be seen gathered in groups, but they usually die before morning.
4. The abdomen or hinder part of the body is often swollen, and the extreme segments or rings droop and are bent underneath the rest of the body.
5. The wings often appear to be disconnected, the upper wings lying flat about the body, while the lower wings stand out from the body as in flight. Sometimes the legs seem affected, and the bees stagger along in their attempt to walk.
6. Finally the whole colony of workers is found massed together in front of the hive or on the ground, except a few which are found crowded around the queen.
7. The field bees are always the first affected. The queen and the brood are not attacked, though "chilled brood" often appears subsequently, owing to there being insufficient bees to keep the hive warm."

PARALYSIS OR DISAPPEARING DISEASE.

Whether these two are the same disease is not known. In both cases the adult bees act very much as in the case of the Isle of Wight disease. Often the bees in one or two colonies in the apiary are affected, and in a few days, although the colonies are weakened, the disease seems to disappear. This malady appears mostly in the spring of the year, and often during or shortly after a spell of bad weather. Strong colonies and vigorous queens are the treatment recommended. Little is actually known about the cause of this trouble.

DYSENTERY.

Properly speaking, dysentery cannot be classed as a disease, because so far as is known, the trouble is due to the bees retaining faeces in the intestines for an unnatural period, or from consuming poor quality winter stores, which contain a large percentage of indigestible matter.

It is known that bees normally retain the indigestible portions of the food, consumed during winter, in the intestines. If, therefore, the winter is longer than normal, or the winter stores are of poor quality and contain a large amount of indigestible matter, dysentery usually results. The faeces are then voided inside the hive, unless the bees are wintered outside and there are frequent flights during the winter months. Dysentery may also be brought about by unduly exciting a colony during the winter period. The beekeeper can always tell when a colony has died from the effects of dysentery, because the combs, frames and inside of the hive are badly stained, as the bees void the faeces inside. The odor is also quite noticeable and consistent.

The combs from a colony which has died from dysentery, may be used over strong colonies later in the season, when they will be cleaned. The wood-work, however, should be thoroughly scraped by the beekeeper before giving these combs to the strong colonies.

If colonies suffer seriously from dysentery during the winter and survive till spring, they may then dwindle rapidly, because of their weakened vitality, and the colony may die in April or May.

When heavy brood-rearing is continued late in the fall, owing to the season or late introduction of young queens, and the young bees do not secure a flight before going into winter quarters, dysentery will develop. This is more noticeable and prevalent in cellar wintered bees.

REMEDIES FOR DYSENTERY.

If the beekeeper will see that the bees winter on good quality and thoroughly ripened honey and there is no excessive excitement during the winter period, dysentery is seldom troublesome. Many beekeepers feed each colony ten to fifteen pounds of sugar syrup for actual winter consumption. This is good practice where the quality of honey is uncertain and dysentery appears regularly.

PESTS OF THE APIARY.

Besides the brood diseases of bees, there are a few pests which may do considerable damage in the apiary and apiary supplies, unless preparations are made to control them.

The most important of these is undoubtedly the Bee-moth or Wax-moth, *Galleria mellonella* L. The larvae of this moth work in the combs, and when present, will destroy drawn combs very rapidly. These larvae have a preference for brood combs, and in a month or two, if not checked, they will destroy thousands of combs. Practically all beekeepers are acquainted with the adults, which



FIG. 9.—Work of the Bee-Moth larvae. Combs a mass of webs.

are often found either inside the hives, from which the bees have died, or in weak colonies. *Professor F. B. Paddock gives the following description of the moths:

ADULT BEE-MOTH.

Description.

"Although very familiar to many beekeepers, the bee-moth is yet not definitely known to those who should be acquainted with it in order that they might more readily combat it. Having been a pest for such a long time, it is remarkable that more beekeepers are not acquainted with this pest of the apiary. Perhaps the reason that these moths are not more commonly known is due to the fact that they are seldom to be seen on the wing, except at dusk, unless frightened from their hiding places."

"The adult bee-moth is about five-eighths of an inch (fifteen millimeters) in length, with a wing expanse of about one and one-quarter inches (thirty to thirty-two milli-

*Bulletin No. 231, "The Bee-moth or Wax-worm," Texas Agricultural Station.

moths. The moth with its wings folded appears ashy gray in color but the back third of each front wing is bronze colored. This wing is thickly covered with fine scales which rub off easily when the moth is touched. On the outer and rear margins of the forewing is a scanty row of short hairs. The hind wings are uniform in color, usually gray, with traces of a few black lines extending from the outer margin inward toward the base; on the outer and rear margins is a thick fringe of hairs on which is a dark line running parallel with the border of the wing. The body is brown, the shade varying with a covering of scales. These scales rub off easily and are not always present on the older moths. The male is slightly smaller than the female. A difference between the sexes is noticed in the forewing, which in the case of the male is deeply scalloped on the outer margin. This scallop carries a heavy fringe of hairs, almost black in color. Another difference is in the mouth parts, the palpi of the male being rudimentary."

In the north this pest does very little damage during the winter, unless the combs are stored in a warm place. From May until October they are active, and it is during the summer months that the damage is done. Their presence is known to the beekeeper by finding the adult moths or the larvae working in the combs. *Professor Paddock describes the larvae as follows:

THE LARVA OF THE BEE-MOTH.

Description.

"When first hatched the young larva (worm) is only one to three millimeters (1-25 to $\frac{1}{8}$ of an inch) in length. They have a dirty white waxy color. The head is slightly yellow and smaller than the prothoracic segment, which is decidedly prominent. The true or thoracic legs are especially well developed and the pro-legs or abdominal legs are not apparent when the larva is first hatched, and only appear normal when the larva is about three days old."

The larvae when fully grown are $\frac{3}{4}$ to 1 inch in length. These larvae work along the mid-rib of the comb, spinning a webbed tunnel as they proceed. If the infested combs are held up to the light their presence is easily seen. Quite often, too, the beekeeper will find the cappings of the sealed brood removed, and the webs of the bee-moth larvae showing. If these webs are removed, quite often the bee-moth larvae can be seen trying to escape. The damage to strong colonies is negligible, as the number of these pests will be controlled by the colony. In the case of strong Italian colonies, they are rarely found, but quite often where black bees are kept, a few of these bee-moth larvae can be found.

Wherever the beekeeper finds more than a few of either the adults or larvae of the bee-moth present, it is certain that the colony is either very weak, queenless, or diseased.

REMEDIES.

Where the pest is found in living colonies, no remedy is necessary if the colonies are strong. Where the colonies are weak, the beekeeper should remove as many of the bee-moth larvae as possible, and then strengthen the colonies. In the combs from which the bees have died, and where they are badly infested, it is a good plan to close the hive tightly and burn the contents.

Where the combs are not too badly infested, as in the case of super combs, and the beekeeper wishes to save these, Carbon bisulphide is recommended for this purpose. *The following tables by Professor Paddock will enable the beekeeper to gauge the correct amount:

*Bulletin 231, "The Bee-moth or Wax-worm," Texas Agricultural Sta.

Amount of carbon bisulphide to use in fumigating ten frame shallow supers for the waxworm.

Number of shallow supers in the tier.	Cu. ft. contained in tier.	Amount of liquid bisulphide required.
2	1.74	$\frac{1}{2}$ ounce
3	2.61	$\frac{3}{4}$ ounce
4	3.48	$\frac{1}{2}$ ounce
5	4.35	1 ounce
6	5.22	$1\frac{1}{4}$ ounce
7	6.09	$1\frac{1}{2}$ ounce
8	6.96	$1\frac{3}{4}$ ounce
9	7.83	2 ounces
10	8.70	$2\frac{1}{4}$ ounces
11	9.57	$2\frac{1}{2}$ ounces
12	10.44	$2\frac{3}{4}$ ounces

Amount of carbon bisulphide to use in fumigating ten-frame hive-bodies for the waxworm.

Number of bodies in the tier.	Cu. ft. contained in tier.	Amount of liquid bisulphide required.
2	2.90	$\frac{3}{4}$ ounce
3	4.35	1 ounce
4	5.90	$1\frac{1}{4}$ ounce
5	7.25	$1\frac{3}{4}$ ounce
6	8.70	2 ounces
7	10.15	$2\frac{1}{4}$ ounces
8	11.60	$2\frac{3}{4}$ ounces

"For eight-frame supers and hive-bodies, use eighty per cent. as much bisulphide as is given in the foregoing tables for the corresponding number of supers on bodies."

"All fumigation should be allowed to continue for at least twelve hours."

When the beekeeper is using carbon bisulphide it must be remembered that the gas from this liquid is heavier than air, so that the bisulphide is always placed in a vessel inside an empty super on top of the tier of supers. Another very important point is to see that these tiers of supers are air tight as possible, or the fumes will escape before they have killed all the pests. They can be made air tight by pasting a strip of paper around the supers, so that the gas will not escape between the supers.

Carbon bisulphide is very inflammable, and when this is being used, the beekeeper must be very careful that no light is near, or an explosion will follow. It is also well not to breathe any more of the gas than possible, as it will soon cause a headache and sickness if much is inhaled. Professor Paddock states that carbon bisulphide will not injure the eggs of the bee-moth, so that the beekeeper should fumigate the combs twice, the second time one month after the first fumigation. With the second fumigation, all that is necessary is to uncover the empty super on top of tier of supers of combs, and pour more carbon bisulphide into the dish, without disturbing the supers. Beekeepers should be very careful not to leave combs scattered around in the apiary in the summer. Once the bee-moth secures a hold in the apiary, it will remain for a long period, ready at any time to destroy combs which it may find.

MICE.

Mice are seldom troublesome in the apiary during the summer. At that period of the year they do most damage to drawn-combs if these are stored where the mice have access to them. It is always well for the beekeeper when storing supers of

drawn-combs to place metal covers or queen excluders below and on top of the tiers of supers.

If the entrances of colonies, wintered outside or in the cellar, during the winter months are large enough for mice to enter, the beekeeper may lose several colonies. The mice will nest in the combs, and so disturb the colonies as to weaken them materially, if not destroy them entirely. For outdoor wintered colonies, entrances should never be deeper than $\frac{3}{8}$ of an inch. Where bees are wintered in the cellar, the beekeeper should take precautions by having traps and poison in the cellar.

SKUNKS, ETC.

Occasionally beekeepers are troubled by skunks. It is said that the skunks will visit one hive night after night, and in some cases will weaken the colony so that it is useless, and may be destroyed. Where these are present, it is an easy matter to dispose of these pests.

Beekeepers in other countries are troubled with numerous other pests including robber flies, dragon flies, wasps and birds, but in Ontario these latter pests are seldom numerous enough to cause damage.

PRECAUTIONS.

1. Never buy colonies of bees unless examined and guaranteed free from American and European foul brood. Consult the Provincial Apiarist, O.A.C., Guelph.

2. If drawn combs, irrespective of age, are purchased with used apiary supplies, they should be rendered into beeswax, unless positive no American foul brood existed in the apiary from which they came.

3. Beware of robbing in early spring. Remove all hives from which the bees have died, to a bee-tight place. Do not use the combs if American foul brood is present. Look for the scales.

4. When treating colonies for American foul brood, be careful not to scatter honey from the infected colony. Always treat during a honey flow. Burn or care for all infected combs and honey or the treatment will be useless.

5. Since honey is one means of transmitting American foul brood it should not be fed to bees, unless its origin and freedom from the germs of American foul brood is known. When in doubt, feed sugar syrup.

6. Both American and European foul brood may occur in the same comb. Make sure your diagnosis is correct.

7. When locating an apiary, locate at least three miles from any other extensive apiary. This means more honey for you and a square deal to the other apiarist.

THE BEE DISEASES ACT.

The diseases of bees, besides being a serious loss to the beekeepers, are causing enormous losses to the country at large. The honey bee has long been acknowledged one of the best pollen distributors that visit the fruit trees, and later flowering bushes that are profitably cultivated for the production of their fruit. They are of equal importance in the production of clover seed and buckwheat. Furthermore, since the apiarist has no means of controlling the flight of his bees, nor that of his neighbors, these diseases cannot be cured unless the beekeepers work

together, and to organize and assist the beekeepers to work together the Ontario Department of Agriculture is conducting a very strenuous educational campaign.

The following is a copy of the Act:

AN ACT FOR THE PREVENTION OF DISEASES AMONG BEES.

1. This Act may be known as *The Foul Brood Act*.
- 2.—(1) The Lieutenant-Governor in Council, upon the recommendation of the Minister of Agriculture, may from time to time appoint one or more Inspectors of Apiaries to enforce this Act.
 (2) The Inspector shall, if so required, produce the certificate of his appointment on entering upon any premises in the discharge of his duties.
 (3) The remuneration to be paid to an Inspector under this Act shall be determined by order of the Lieutenant-Governor in Council, and shall be payable out of any sum appropriated by the Legislature for the enforcement of this Act.
- 3.—(1) The Inspector shall whenever so directed by the Minister, visit any locality in Ontario and examine any apiary to which the Minister directs him, for the purpose of ascertaining if any infectious or contagious disease of bees exists in such apiary.
 (2) If the Inspector finds that foul brood exists in a virulent or malignant type he shall order all colonies of bees so affected, together with the hives occupied by them, and the contents of such hives and all tainted appurtenances that cannot be disinfected to be immediately destroyed by fire under his personal direction and superintendence.
 (3) Where the inspector, who shall be the sole judge thereof, finds that an infectious or contagious disease, not being foul brood of a virulent or malignant type, exists among the bees he shall give notice in writing to the bee-keeper instructing him as to the treatment of such disease and stating the time within which such treatment shall be given, and if at the expiration of such time the diseased colonies have not been treated by the bee-keeper in accordance with the notice, the same may be treated by the Inspector and the bee-keeper shall be liable to the Inspector for all expenses incurred in such treatment.
4. The Inspector may order the owner or possessor of any bees dwelling in box or immovable frame hives to transfer them to movable frame hives within a specified time, and in default the Inspector may destroy, or order the destruction of such hives and the bees dwelling therein.
- 5.—(1) Where infectious or contagious disease exists in an apiary the owner or possessor thereof shall not sell, barter, give away or remove from the premises any bees or used apiary appliances or apparatus until he has secured a certificate from the provincial apiarist that such bees, used apiary appliances or apparatus have been properly disinfected and are free from disease.
 (2) Bees or used apiary appliances or apparatus shall not be imported into Ontario from any other Province in Canada or from any State in the United States of America unless accompanied by a certificate from a provincial or state officer certifying that such bees, used apiary appliances or apparatus are free from any infectious or contagious disease, but this shall not apply to the importation into Ontario of bees apart from combs.
 (3) Every person who contravenes the provisions of subsection 1 or of subsection 2 of this section shall be guilty of an offence and shall incur a penalty of not less than \$50 nor more than \$100.
6. Any person whose bees have been destroyed or treated for foul brood, who sells or offers for sale any bees, hives or appurtenances of any kind, after such destruction or treatment, and before being authorized by the Inspector so to do or who exposes in his bee-yard, or elsewhere, any infected comb, honey or other infected thing, or conceals the fact that said disease exists among his bees, shall incur a penalty of not less than \$20 and not more than \$50, or he may be imprisoned for a term not exceeding two months.
7. Any owner or possessor of bees who refuses to allow the Inspector to freely examine bees, or the premises on which they are kept, or who refuses to destroy the infected bees and appurtenances, or to permit them to be destroyed when so directed by the Inspector, shall, on the complaint of the Inspector, incur a penalty of not less than \$25 and not more than \$50 for the first offence, and not less than \$50 and not more than

\$100 for the second and any subsequent offence, and the convicting Justice shall by the conviction order the said owner or possessor forthwith to carry out the directions of the Inspector.

8. Where such owner or possessor of bees disobeys the directions of the said Inspector, or offers resistance or obstructs him, a Justice of the Peace may, upon the complaint of the Inspector, cause a sufficient number of special constables to be sworn in, who shall under the directions of the Inspector, proceed to the premises of such owner or possessor and assist the Inspector to seize all the diseased colonies and infected appurtenances and burn them forthwith, and if necessary the Inspector or constables may arrest the owner or possessor and bring him before a Justice of the Peace to be dealt with according to the provisions of the preceding section.

9. Before proceeding against any person before a Justice of the Peace, the Inspector shall read over to such person the provisions of this Act or shall cause a copy thereof to be delivered to him.

10. Every owner or possessor of bees, and any other person who is aware of the existence of foul brood either in his own apiary or elsewhere shall immediately notify the Minister of the existence of such disease, and in default of so doing shall incur a penalty of \$5.

11. Each Inspector shall report to the Minister as to the inspection of any apiary in such form and manner as the Minister may direct, and all reports shall be filed in the Department of Agriculture, and shall be made public as the Minister may direct or upon order of the Assembly.

12. *The Ontario Summary Convictions Act* shall apply to all prosecutions for offences against this Act.

13. The Act passed in the 6th year of the reign of His late Majesty King Edward the Seventh, and section 27 of the Act passed in the 10th year of the said reign, chaptered 26, are repealed.

INSPECTORS' DUTIES.

It will be seen by Sec. 3 that it is an inspector's duty to work under the direction of the Minister of Agriculture or the one he may appoint to administer the Act. Where foul brood is found he is to destroy by fire the worst cases, especially where the beekeeper is not making a successful effort to cure.

TRANSFERRING BEES.

Aside from the standpoint of disease, bees should not be kept in box hives as described in section 4. All modern methods of management demand that the combs be built in movable frames. It is as impossible to tell the condition of the brood, the queen or the honey, inside the hive simply by glancing at the entrance, as it is to read a book without opening the covers. Many methods are used to transfer bees from box to movable frame hives. [See Circular No. 27.]

DISPOSING OF BEES OR APPLIANCES.

Section 5 puts a heavy penalty on disposing of diseased bees or appliances in any way, and, according to Section 6, persons whose bees have been treated or destroyed for disease shall not dispose of any bees or appliances whatever without permission for the inspector, or expose in the apiary or elsewhere any infected material or honey on penalty of fine or imprisonment.

INFORMATION CONCERNING LOCATION OF DISEASE.

Sections 7, 8 and 9 give inspectors power to act. Section 10 requires every person who is aware of the existence of foul brood to report the same to the Minister of Agriculture, and Section 11 requires the inspectors to report on all their work to the same authority.